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November 2, 1978

Dear Stan:


Herewith I am enclosing a copy of an article which has just appeared in our Fall issue of ORBIS entitled, "Central War and Civil Defense" by T. K. Jones and W. S. Thompson. I know both of the authors quite well and am greatly impressed by their familiarity with the subject, as well as their intellectual integrity. They take issue with the report which you released on "Civil Defense" in July 1978 and which was published in the State Department special report #47, September 1978.

Jones and Thompson make a powerful case for taking the Soviet civil defense program far more seriously than the report which you released seems to do. The issue is of such importance that perhaps your people would like to make a public critique of the Jones-Thompson analysis.

I trust you are enjoying the hot spot which you are currently occupying.

With all good wishes,

Sincerely,


William R. Kintner

Admiral Stansfield Turner
Director of Central Intelligence
Central Intelligence Agency
Washington, D.C. 20505

WRK:deg

Enclosure: as stated

*To NFAC, via ES, for reply.
13 Nov 78*

CENTRAL WAR AND CIVIL DEFENSE

by T. K. Jones and W. Scott Thompson

The study of nuclear war is seldom associated with scientific enquiry. Carl von Clausewitz aptly compared war to a game of cards in its "interplay of possibilities, probabilities, good luck and bad."¹ Writing in the early nineteenth century, he observed that war "is the realm of uncertainty; three quarters of the factors on which action is based are wrapped in a fog of greater or less uncertainty."² Thus, the most important question of all—whether nuclear war will occur—is not, as such, susceptible to scientific study. Probabilities can be attached to different possibilities, but in the final instance, the critical and rapidly changeable variable—the intent of the adversaries at the critical hour—is quantifiable only in a crude way, one with little predictive validity.

True, the question of intent can be "measured" by the methods of history, and there is no doubt much to be learned from such enquiry. Whether, for example, adversaries go to war when certain critical levels of armament are reached, or when one side believes it could dictate its terms at the conclusion of a hypothetical war, may well be examined for today's world in the light of past events. But this is not science in any controlled sense. In recent years, the disposition toward scientific enquiry in the study of nuclear war became unpopular in America, just as the military superiority that guaranteed America's freedom from attack inexorably declined. Possibly this is a consequence of the inevitable association of nuclear scientists with nuclear proliferation; perhaps it is simply the distastefulness of a warfare so ghastly to contemplate. More recently, the notion has been advanced—in its most sophisticated form by George Kennan—that analysis of the nuclear balance between Russia and America is largely a

¹ *On War*, trans. and ed. by Michael Howard and Peter Paret (Princeton, N.J.: Princeton University Press, 1976), p. 86.

² *Ibid.*, p. 101.

T. K. Jones, Manager of Program and Product Evaluation with the Boeing Aerospace Company, was Senior Technical Adviser to the Department of Defense and a Representative at the SALT talks during 1971-1974.

W. Scott Thompson, Associate Professor of International Politics in the Fletcher School of Law and Diplomacy, was Assistant to the Secretary of Defense during 1975-1976. He is a member of the ORBIS Editorial Board.

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waste of time compared with the much more important task of examining the motives of the Soviet leadership—who, Kennan avers, could not in their conservative frame of mind seek nuclear war.³ It is, to be sure, odd that such an insistence on the benign motives of that leadership comes just when the Soviets have achieved parity (at least) in armed forces and, by most quantitative measures, strategic superiority,⁴ just when their surrogate and clandestine forces are fighting to sustain unpopular regimes throughout the Middle East and Africa, and just when Soviet gunboats are bombarding ports on the Red Sea.⁵

Even if one grants—indeed, insists—that the truly important questions for national leadership will remain those in the realm of prudence, not science, is there not a role for scientific enquiry in assessing some of the issues that should be factored into judgments of how to avoid nuclear war and how best to deal with a war if it cannot be avoided? The American philosopher Charles Peirce wrote that there are four ways of knowing, of “fixing belief”: the method of tenacity, the method of authority, the *a priori* method—and the method of science.⁶ As we understand the method of science, it is, in the first instance, a method applicable to the examination of any phenomenon where the variables can be isolated and the operations replicated. The relationship between independent and dependent variables can be specified, yielding empirically verifiable generalizations with predictive power.

We believe that the scientific method—and the spirit of scientific enquiry—can be used to narrow the range of uncertainty in the important questions that will face a U.S. president in the event of a nuclear crisis.⁷ Our premise is that by working

³ “A Current Assessment of Soviet-American Relations,” remarks by George Kennan at a meeting of the Council on Foreign Relations, Washington, November 22, 1977.

⁴ See, in particular, “Measures and Trends, US and USSR: Strategic Force Effectiveness,” draft interim report, Defense Nuclear Agency, February 1978, and discussion below.

⁵ See P. Janka, “Kremlin’s Buildup in the Horn,” *Soviet Analyst*, January 26, 1978, p. 6. For a report on the bombardment by two Soviet destroyers, see Reuters dispatch, January 18, 1978. See, also: Foreign Broadcast Information Service (FBIS), *Daily Report*, June 6, 1978; Damascus Domestic Service and FBIS, *Daily Report* for May 24, 1978; and al-Ayam (Khartoum), May 23, 1978. For general background on the growth in the projection of Soviet power, see W. Scott Thompson, *Power Projection* (New York: National Strategy Information Center, 1978).

⁶ Cited in Fred N. Kerlinger, *The Foundations of Behavioral Research: Educational and Psychological Inquiry* (New York: Holt, Rinehart & Winston, 1964), pp. 6-7.

⁷ According to Lawrence C. Mayer, the empirical character of scientific knowledge gives it two advantages over other analytical approaches: “First, only statements which are based on events or states of affairs in the real world can tell us something about

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not with the unknown in the realm of motive or the realm of prophecy but, rather, with the already knowable, one can shed some light on what would happen if deterrence fails and central war—that is, thermonuclear war between the Soviet Union and the United States—occurs. One can identify the choices available to a national leader during such a conflict, and for each of these choices one can evaluate his ability to control escalation and assess the consequential damage to the nation and its postwar viability. All this can be done with relatively straightforward calculations, using the appropriate: If x conditions prevail, then y results will obtain.

Having assessed what the “knowable” is, at least within certain parameters, a national leader can venture into the much more important realm of prudential judgment, better armed to examine the ways in which the military relationship of the superpowers might affect the intentions of either in a crisis and shape the decisions that will determine the outcome should deterrence fail. In calculations involving as many variables as are used in this study, some margin of uncertainty is inevitable. Since the same method is used to examine the forces and choices of both sides, the overall relationship between Soviet and American forces should, however, be evident, particularly since the very large imbalances shown to exist can be erased only by massive changes to the input data and assumptions. The key point is that the method of science can be used for such study: the results are replicable, and the operations have been reviewed by others for their validity.⁸ It is significant that some of those disagreeing with the resulting data have advanced reasons why the methods overstate Soviet capabilities, while others have advanced reasons why the methods overstate U.S. capabilities, a point elaborated upon later.

There are strong indications that the Soviet side has calculated the balance with methods similar to those used herein and that it is predisposed to consider the balance in terms of conflict outcomes.⁹ Whether or not an American administration is pre-

that world. . . . second, the empirical base of scientific statements minimizes subjectivity” by neutralizing the biases of different observers. (*Comparative Political Inquiry* [Homewood, Ill.: Dorsey Press, 1972], p. 6.)

⁸ For information on the methodology used in this study, see T. K. Jones’s testimony in *Hearings before the Joint Committee on Defense Production*, November 17, 1976.

⁹ See Major-General Anureyev, “Deterring the Correlation of Forces,” *Voyennyye Mysli* 6/67, FPD #0012/68, July 11, 1968, for an example of the conceptual sophistication of Soviet strategic planning. General Anureyev uses a war-gaming approach in order to ascertain balances after a nuclear exchange, much as is done in the United States. The

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disposed to consider the balance in similar terms, rather than considering it so horrible to contemplate that it is not contemplated, perhaps matters little in practice: come a crisis, the national leadership would be forced to think about war outcomes and national survival in the analytical way we have suggested. But it would be in that leadership's interest to do so *prior* to a national emergency, since this should affect its defense program and budget in a significant way.

A final, and critical, introductory note: Many who argue against the appropriateness of analyzing nuclear war do so on the grounds that such a conflict would be so terrible that it must be avoided at any cost. Even if one accepts that premise, a pragmatic analysis to determine what is likely to occur during a U.S.-Soviet nuclear war and what the consequences will be for both nations is an essential factor in deciding what concessions or appeasements should be offered to avoid war. Another reason why objective calculation of war outcomes is important to the avoidance of war is that, historically, most wars have occurred not by design but through miscalculation, by one or both parties, of the strength and intentions of the other.

II

In the event of a crisis, it is our contention that neither Soviet nor U.S. leaders, whatever their past rhetoric, will look at their situation solely in terms of avoiding a "holocaust"; rather, they will disaggregate the threat and consider the possible outcomes in terms of the least unpalatable possibilities. For example, a national leader examining the option of a nuclear attack against an opponent's deterrent force would consider, first of all, whether his strength after such a counterforce strike could forestall or inhibit retaliation by the opponent's surviving forces and, secondly, what the likely outcome would be if the opponent did retaliate. Related questions include not just which targets should be attacked but which targets should be attacked in first-, second- and third-strikes, what proportion of one's arsenal should be allocated to each strike, and how much should be held as a postwar reserve.

Official documents of both the U.S. and the USSR indicate that relative strength as well as postwar recovery are con-

result is not just a better knowledge of the balance but a greater appreciation of what factors are critical to success and, therefore, of where R&D should be devoted, which systems should be improved, and so forth. We are grateful to Joseph Douglass, of System Planning Corporation, for bringing General Anureyev's article to our attention.

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sidered important by both nations. Relative strength at each point in a potential or ongoing conflict affects the ability to control escalation and determines the quality of terms that each side could exact upon cessation of hostilities. Postwar strength would be of major importance to a would-be aggressor since it determines his ability to achieve the original objective. A relatively slow rate of postwar recovery could subject a nation to both military and economic domination because the opponent might recover strength and, hence, coercive capability more quickly.

Because relative advantage at all points in a potential conflict can be estimated, it is reasonable to expect that the results of such estimates would influence the behavior of opponents in a crisis. A nation believing that it could tolerate escalation while its opponent could not would probably remain steadfast in its demands and could realistically expect the opponent to yield. That, of course, was the situation in the 1962 Cuban Missile Crisis during which Moscow had every incentive against escalation and chose to back down. Since 1962, the strategic balance has shifted dramatically and has consequently altered America's views of how it could handle a crisis with the USSR. For example, the current effort to strengthen the conventional defenses of NATO stems from the realization that we no longer have the "nuclear umbrella" that once prevented Soviet use of its superior conventional forces.

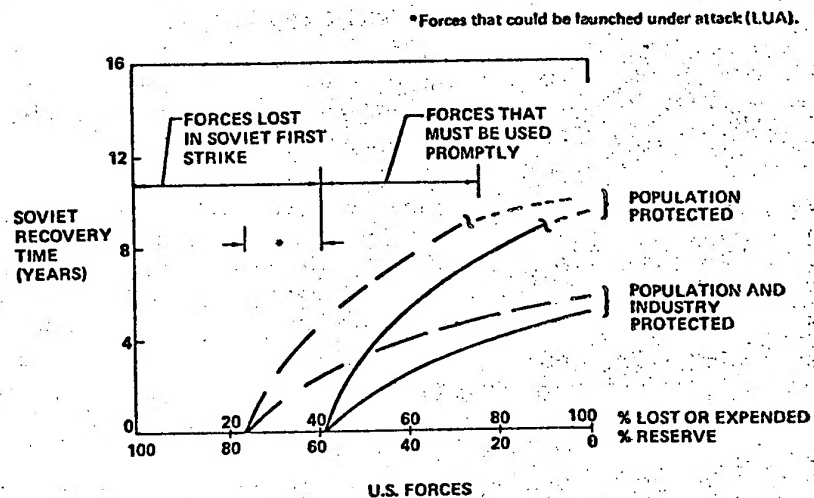
The method we have used to calculate the balance recognizes that each opponent is most likely to follow the course of action most favorable to its own interests. The approach taken was to depict each side's options in decision-logic form, an exercise that forces the analyst to recognize that while the U.S. would hypothetically have several second-strike retaliatory options for each Soviet attack option, the Soviets would in most cases have third-strike options that, in practice, should shape the U.S. choice of whether or not to use its second-strike strategy. Because both nations have explicitly stated the importance of strength and recovery, our approach has been to measure the balance in those terms.

The results (see Figures 1 through 6) illustrate the application of this measurement to the minimum-deterrence doctrine, on which so much of American strategic thought has been based, and by which the U.S. would retaliate against Soviet cities. The forces used are those which each nation is expected to have in 1985 under the terms of the currently envisaged SALT II treaty.

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FIGURE 1

Impact on Soviet Recovery U.S. Countervalue Responses



As in most strategic analyses, this one assumes that any Soviet attack will be preceded by a period of increasing tension, during which the U.S. forces will have been placed on fully generated alert and the Soviets will have executed their civil-defense plan.

A Soviet attack on fully alerted forces would destroy about 40 per cent of the U.S. inventory. (See Figure 1.) The 60 per cent surviving could, under the minimum-deterrence option, be used to retaliate against their urban-industrial areas. If our entire surviving force were so used, it would take the Soviets approximately ten years to return to their full prewar GNP if they protected only their population (about five years if they protected both population and industry).

Two other factors affect the American choices. The U.S. could launch its missiles in the brief interval before Soviet missiles hit their American targets. Although "launch under attack" (LUA) would increase the force available for use against Soviet urban-industrial targets, our data show that it does not have a large marginal impact on their recovery time because the otherwise-surviving force could destroy the more important targets. Secondly, a large percentage of the U.S. force surviving the initial attacks would have to be used rather promptly thereafter. Part of the

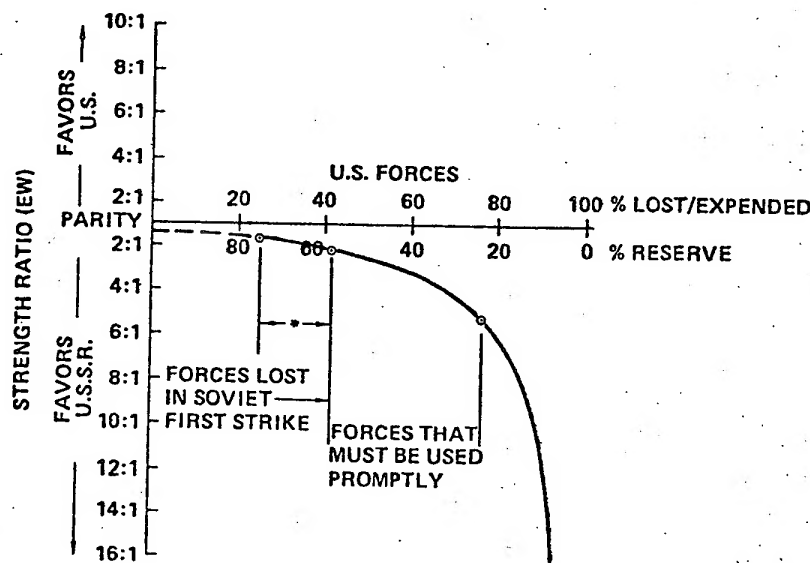
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problem is, that a properly designed Soviet attack would leave the U.S. with no place to hold or recover its bombers or the tanker aircraft essential to their use. Furthermore, the electrical power essential to keeping U.S. ICBMs in launch-ready condition is much more vulnerable than the silos. Even if a number of silos were to survive, many of those would have to be used before the in-silo batteries ran down, within a matter of days at best. Although submarines at sea theoretically could endure for a much longer time, the survival of their communications links is, at best, problematic.

To impose the ten-year and five-year Soviet recovery times noted above would require that the U.S. exhaust most of its initially surviving arsenal in counterindustrial attacks while leaving the Soviet conventional and strategic reserve forces largely intact. Figure 2 shows that the greater the recovery-time penalty imposed on the Soviet Union, the more one must give up relative reserve strength, leaving the Soviets with a margin of superiority that in-

FIGURE 2

Impact on Postwar Strength U.S. Countervalue Responses



* Forces that could be launched under attack (LUA).

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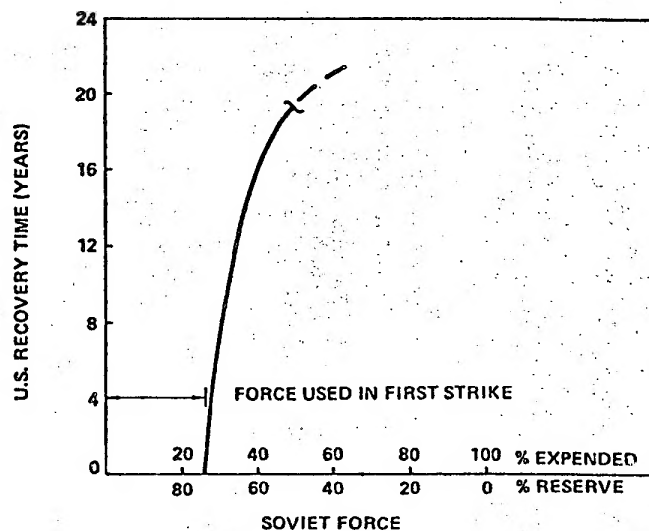
creases with a worsened recovery problem. If the United States exhausts its reserves, it guarantees that the other side can impose any war-termination terms it wishes.

The U.S. second-strike against Soviet industrial areas (as envisaged under the minimum-deterrence concept) would probably trigger a Soviet third-strike in kind. Figure 3 shows that the Soviets would have used up about 25 per cent of their force in the first (counterforce) strike, leaving them with 75 per cent which could be used in a third-strike against American cities and industry. Because the U.S. now protects neither population nor industry, the USSR could impose, for example, a twenty-year recovery penalty on the United States and still keep a reserve equal to 40 per cent of its initial deployed strategic force.

Each nation, of course, can exercise its own, independent judgment about how much of its force it should hold in reserve. Figure 4 shows the effect of these choices on the relative speed of national recovery. At the end of a U.S. second-strike on Soviet cities, the U.S. would have a recovery-time advantage. But, by expending only about 15 per cent of its force in a third-strike on U.S. cities, the Soviet Union could reverse this to more than a 2:1

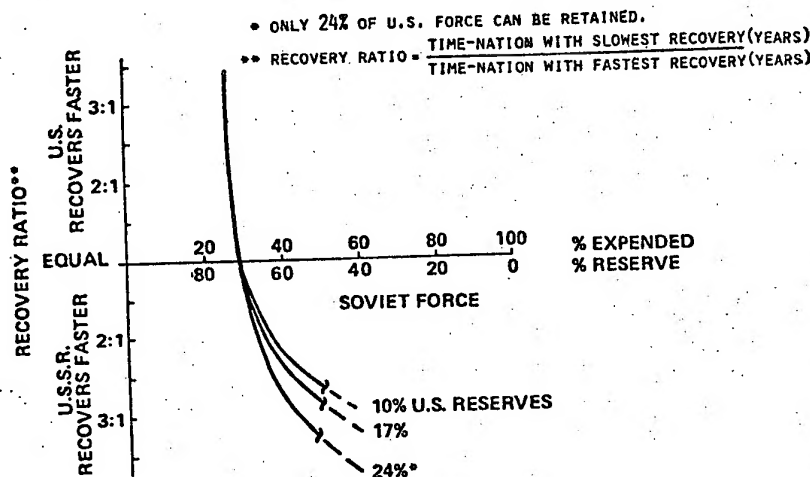
FIGURE 3

Impact on U.S. Recovery—Soviet Follow-On Attack



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FIGURE 4

Relative Speed of National Recovery—
The Impact of Each Side's Decision

recovery-time advantage in its own favor. Moreover, the American choice of reserve level has little influence on how much strength the Soviets would have to spend to get such a 2:1 recovery-time advantage.

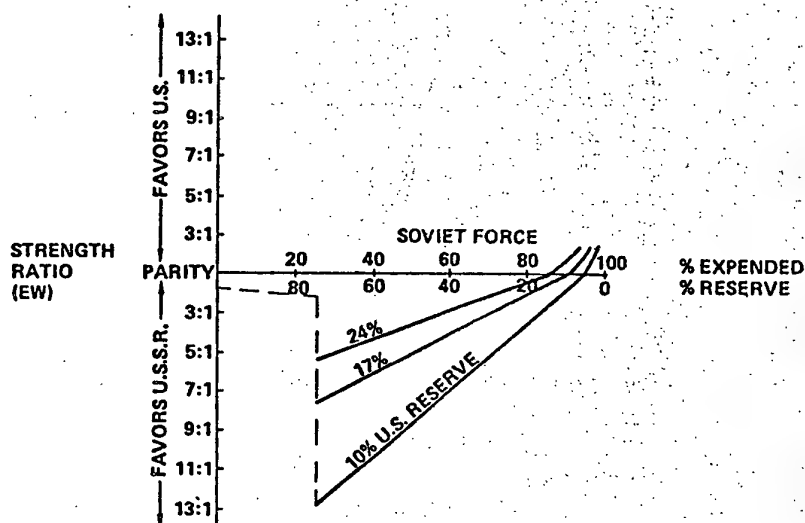
Figure 5 shows the effect of these reserve-force choices on the balance of postwar strength. At the end of the Soviet first-strike, the USSR would have a 2:1 remaining-strength advantage. If the U.S. retaliates against Soviet cities, the Soviet remaining-strength advantage will increase to about 5:1 if the U.S. holds 24 per cent of its force in reserve, to 13:1 if the U.S. withholds only 10 per cent. In other words, the greater the American retaliation, the more adverse the ratio of postwar strength to the United States. If the Soviets then strike U.S. cities, by the same token, it will cost them some of their strength advantage, though not commensurate to the American cost.

In Figure 6, the factors illustrated in the first five figures are combined. The conflict outcomes most favorable to the United States are those in the upper-left quadrant, where both relative recovery and reserve strength favor that country. The outcomes least favorable to the U.S. are those in the lower-right quadrant,

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FIGURE 5

Relative Strength— The Impact of Each Side's Decisions



*Only 24% of U.S. force can be retained.

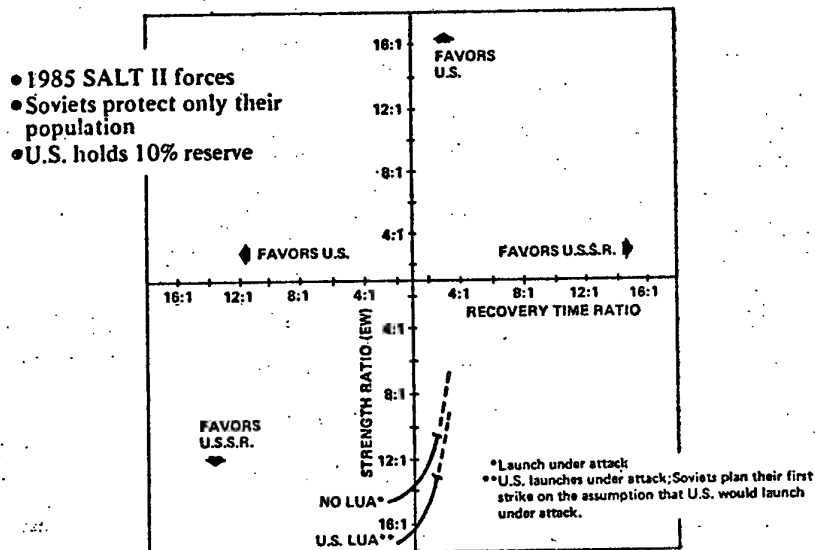
where the Soviet Union would be strategically stronger and would recover sooner than the United States. Our data assume that the Soviet Union is protecting *only* its population and that the United States is holding 10 per cent of its strategic force in reserve (a common planning assumption). The American choice of a 10 per cent reserve establishes that the conflict outcome will be *some-where* along the lines shown, the final outcome being determined by the Soviet Union.

If the Soviets elect to forgo a third-strike, they would have a 13:1 remaining-strength advantage, but the U.S. would have a substantial recovery-time advantage. A much more likely Soviet choice, however, would be to trade some of their strength advantage for a recovery advantage; ending, for example, with a 12:1 strength advantage and a 2:1 recovery-time advantage over the United States. The key point here is that the Soviet Union, exercising its most rational choices, can force the United States into the lower-right, or least favorable, quadrant by deciding to launch a third-strike.

A second important point illustrated in Figure 6 is that

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FIGURE 6

Strength Versus Recovery
Countervalue Responses

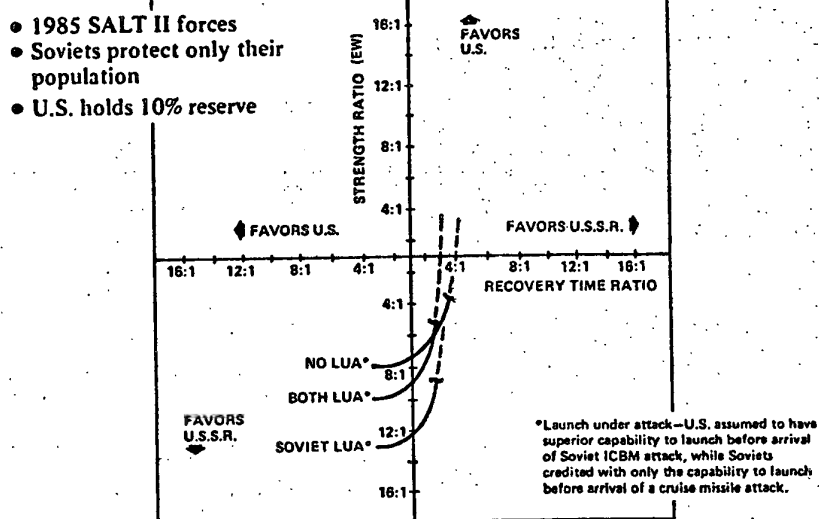
launch under attack does not necessarily improve the outcomes for the U.S. The usual view, that LUA is beneficial, rests on the assumption that the Soviets would not account for this possibility in their attack plan and, hence, would launch a heavy attack against empty U.S. ICBM silos. But the Soviets could also plan their attack on the assumption of an American LUA and might launch only enough missiles to trigger an American launch. Should the U.S. not launch, further increments could be added to the Soviet attack, with outcomes never less favorable than the no-LUA case. In sum, it appears that if the U.S. becomes more firmly committed to LUA, it will become more in the Soviets' interest to plan their attack accordingly and, therefore, more detrimental to the U.S. if countercity retaliation is its doctrine. LUA is surrounded by other problems, more widely recognized — the vulnerability of U.S. warning links to simple sabotage and the loss of escalation control once LUA has occurred.

An alternative response (Figure 7) would be for the U.S. to use some of its surviving force to reduce the Soviet reserve-force strength. (Our analysis also assumes that such a response

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FIGURE 7

Strength Versus Recovery Counterforce Responses (Followed by Countervalue Exchange)



would be followed by attacks against cities.) The data show that the Soviets could still force the U.S. into the lower-right (most unfavorable) quadrant. Launch under attack is a mixed blessing.

Figure 8 compares the relative merits of retaliating against Soviet urban/industrial centers versus retaliating against their reserve forces even if it is assumed that retaliation would escalate to countercity attacks. Two factors are illustrated. First, reserve-force choices appear to have more of an impact on postwar strategic strength than on postwar recovery. Secondly, retaliation against the Soviet reserve forces (a) results in postwar strength ratios less unfavorable to the United States than those resulting from purely countercity responses and (b) does not materially worsen the recovery ratios.

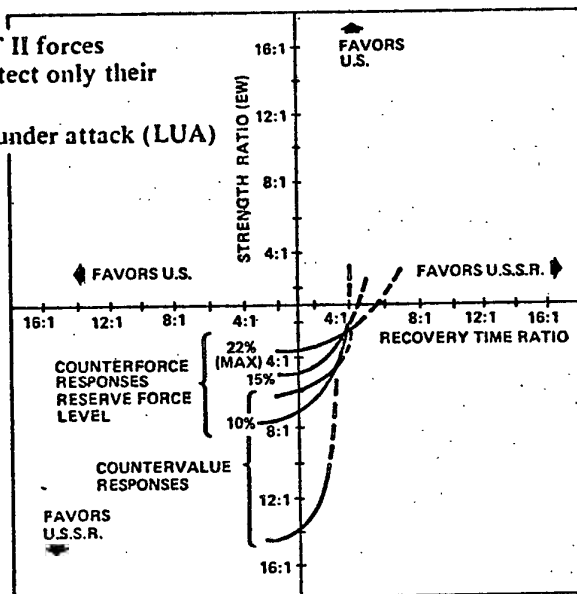
Figure 9 illustrates some other choices available to the two sides. The Soviets could simultaneously attack U.S. forces and cities and emerge with a 6:1 strength advantage and a 2:1 recovery-time advantage, which is as well as they could do by a sequenced attack in which they strike U.S. forces, absorb a U.S. counterforce response, and then escalate to a countervalue ex-

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FIGURE 8

Strength Versus Recovery (Counterforce Exchange—Countervalue Exchange)

- 1985 SALT II forces
- Soviets protect only their population
- No launch under attack (LUA)



change. The argument against a simultaneous counterforce-counter-value attack is that it would virtually eliminate any possibility that the Soviets might dissuade the U.S. from retaliating. Another option would be for the U.S. to withhold its forces following a Soviet counterforce strike and to negotiate a cessation of hostilities. For reasons previously noted, the surviving U.S. ICBMs would become operationally useless and the bombers, assumed to be held on unattacked runways, would become vulnerable to attrition by further Soviet strikes. The result is to move the final strength balance much further in favor of the USSR and to flatten the strength-recovery curve so that the Soviets would be able to push the U.S. far out on the recovery scale.

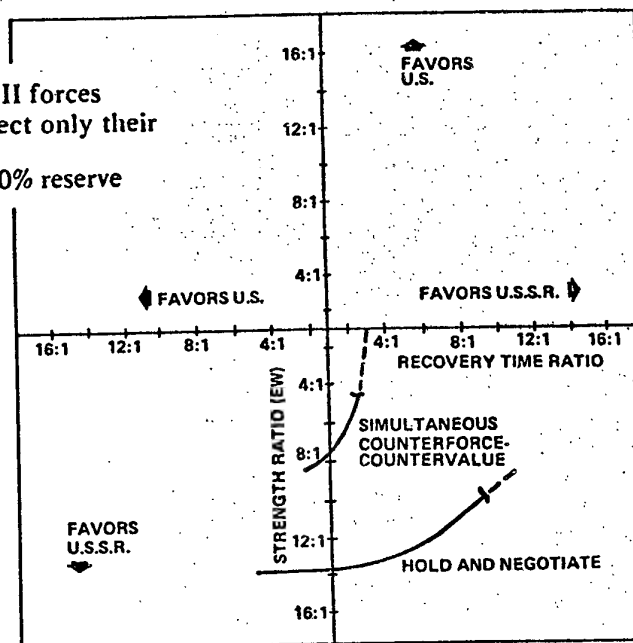
A common question raised regarding such data as are shown in Figures 1 through 9 is whether use of some other index of strength would improve the outlook. ("Equivalent weapons," the index used here, accounts for the size and accuracy as well as the number of weapons.) Figure 10 shows that although the choice of

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FIGURE 9

Strength Versus Recovery Other Responses

- 1985 SALT II forces
- Soviets protect only their population
- U.S. holds 10% reserve



indices does affect perceived outcomes, the U.S. would in any case be at a disadvantage ranging from 2:1 to 4:1. Which index would be most important in the postwar world depends upon whether it is important to attack large numbers of targets, destroy various types of targets, or produce fatalities.

III

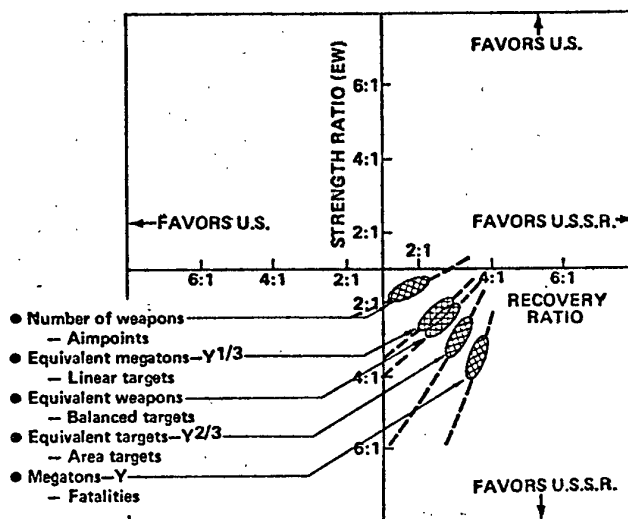
The above analysis was based on an assumption of Soviet civil-defense protection for their population only. What happens if civil-defense measures are also used to protect industry? Is it in fact possible to protect industry, such that recovery time is affected substantially? Let us first of all look at the results of a two-year study on industrial survival that was conducted at and by the Boeing Aerospace Company. We can then examine the interaction of industrial protection, civil defense, and war outcomes.

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FIGURE 10

Which Index to Use?

1985 Counterforce Exchange Followed by Countervalue Exchange



The classic picture that Air Force Intelligence found in the Soviet periodical literature on civil defense, showing the Soviet approach to hardening their means of industrial production, is well known. At Hiroshima and Nagasaki, most of the damage had been caused by fire; the second factor was debris from collapsing buildings; blast and other direct nuclear effects was only a third-order problem. Hence, the Russian method: packing machinery with dirt. This fireproofs the machine very effectively, protects it from most debris and increases its blast resistance by a factor of 4 to 8.

A few simple computations showed that even this rather modest level of protection might have a significant effect on targeting and on industrial recovery. But the overriding question came down to the matter of practicality. Could it be done within a reasonable length of time? Specifically, could it be done in the three days or so that the Soviets say it is going to take them to execute their evacuation plan? To resolve these questions it was necessary to test the Soviet concepts in a U.S. factory. The Boeing team read the Soviet literature and then, step-by-step, prepared a plan following the Soviet instructions and procedures. It was clear

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to the team's production experts that the assembly buildings did not need to survive since airplanes can be assembled in the open (as the Russians did in World War II). What is crucial to production is the machinery that cuts the metal and does the milling. Thus, the facility most crucial to protect is the central machining facility. To give perspective, that facility contains large quantities of standard industrial metal-cutting equipment, lathes and milling machines. Most of this machinery is structurally tough and hence easy to protect using the Russian methods. Other machinery, however, posed some special problems: sheer size, for example. One machine that contour mills aircraft-wing skins is 12 feet wide and 135 feet long. There also are tanks full of corrosives used for treating metal parts. If these chemicals slopped over the other machinery, very serious damage would result. In regard to the chemicals, a solution was found in the Soviet book describing the protection of the Moscow First State ball-bearing factory, for which holding tanks (into which the chemicals could be drained) were built.

Preliminary analysis showed that to protect against the weapons in the U.S. arsenal, the Russian solution of simply packing sandbags or dirt around the machines would be quite effective. The Russian weapons, however, are considerably bigger than those of the U.S.¹⁰ and could cause ground-motion that might destroy even heavy machinery. To protect U.S. machinery from such weapons, a more advanced form of protection described in the Russian literature would be required: namely, to mount the machine on wooden blocks or on a base of crushable material — Styrofoam®, bottles cast in plaster, sawdust, anything that contains air space and will crush at high shock loads; then, to pack the machines with crushable material and cover them with dirt or sandbags. (The most practical plan was to take metal chips, a normal byproduct of machining, pack them around the machines and then fill the building with dirt.)

At this point, a series of tests verified the practicality and effectiveness of Soviet protective methods. The first question was, How many manhours does it take to bury a machine? The easiest way to answer that was to bury one. A machine was placed on a Styrofoam crushable base, covered with plastic to keep off moisture and packed with bags of metal chips. Finally, the machine and its packing were covered with dirt. Since in any nuclear attack the buildings would be destroyed, the buried machine was left

¹⁰ The average yield of U.S. weapons deliverable after a Soviet counterforce strike is .175 megatons, compared with 1.75, or ten times that yield, for the Soviets.

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outside, exposed to sun and rain. Six weeks later, it was dug out, checked for corrosion and tested. Since corrosion protection had been applied, there were no problems except for a few rust spots.

The next portion of the program involved a series of high-explosive tests. High-explosive testing is the standard method used to test nuclear survivability of the B-52 and the Minuteman ICBM and its command centers. The group that did the survivability testing for Minuteman was assigned to do the industrial-protection tests, and they used the same methods and scaling laws. The high-explosive tests included use of up to 500 tons of TNT. To test the equipment at various levels of overpressure, it was placed at selected distances from the explosive charge.

Previous nuclear testing has demonstrated that, without protection, an overpressure of as little as 10 psi will destroy even a heavy machine tool. With protection, even such relatively fragile equipment as calculators can be protected against rather high overpressures. Some calculators were tested in an area subjected to 200 psi; one was packed in chips and covered with a foot and a half of dirt, and there was no visible or functional damage to that machine. Other calculators, tested at 300 psi, were noisier than they were before the tests started, but their answers were right.

Because there were no failures in the first series, a specimen was tested at 600 psi. A small motorbike was selected as the test object, useful because it has several types of structure and could be functionally tested after the explosion. After the test, the front fender was slightly misaligned, and the handlebars were off-center by about 5 degrees. The machine had been buried without removing the gasoline or the lubricants. It was dug out, started and driven away.

No unintentional failures having occurred at overpressures up to 600 psi, an additional test was designed to find the upper limit of overpressure protection provided by Russian methods. Calculators were tested at 700 psi: some, not packed in chips but covered with loose soil, sustained deformation of the sheet-metal case. Variable-drive units, more representative of the toughness of machine tools, were also tested and were placed to receive the maximum overpressure levels obtainable in the test. The original location of the objects was inside what was to become the crater. The force of the blast moved them almost four feet, and the overpressure at that location was 1,300 psi. Scaling for the size of the explosion would indicate that a large lathe or milling machine could be protected at 1,300 psi from a 40-kiloton blast and

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that, against a 1-megaton blast, very large machines could be protected. In sum, a firm upper limit above which industrial machinery cannot be protected against overpressure has not yet been found. A more troublesome limit has to do with the ground motion resulting from large-yield weapons. After a Soviet first-strike, however, the U.S. could deliver very few large-yield weapons, so ground motion is not likely to be a serious problem for the Soviets.¹¹

The most recent test involved two industrial buildings typical of the many small machine shops providing most of the metalworking capacity in the Seattle area. Each building was equipped with machine tools representative of such shops, and the machinery in one building was protected using the Soviet methods. The unprotected building and its machinery were destroyed beyond any hope of repair, while the protected shop was returned to nearly full productive capacity within the equivalent of four days of the 200-300 psi blast. Although 25 per cent of the machinery was damaged, it could have been repaired within two days using the undamaged equipment and supplies in the shop.

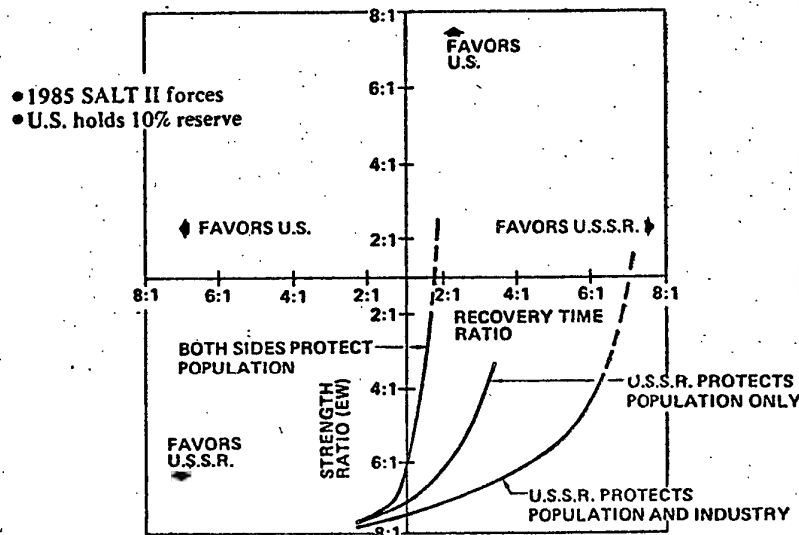
The effects of industrial protection can be illustrated by examining a typical large industrial city, such as Leningrad. The common belief is that one A-bomb will destroy a city. The reality is that even the largest weapon in the American arsenal possessed in any reasonable quantity, about 1 megaton, cannot destroy the industry of a large city. It would take eight 1-megaton-yield weapons on target to achieve 70 per cent damage on the industry of a city the size of Leningrad, even with no industrial civil-defense protection. If the machinery were hardened to an average of 40 psi, it would take 24 1-megaton weapons to achieve 70 per cent damage. (Forty psi is probably a good average level for an industrial-hardening program that does not strive for any miracles or technological breakthroughs. It assumes that some industry will not be hardened at all and that some of it will be hardened very well.) Minuteman III and the cruise missile have warheads in the 200-kiloton range. It would take 56 of those to achieve 70 per cent damage. If one uses the most numerous warhead in the U.S. arsenal, the Poseidon SLBM warhead, 111 weapons on target would produce only about 40 per cent damage.

¹¹ The average yield of surviving U.S. weapons (175 kilotons) would have a lethal area of about 7 square miles for unprotected machinery but only a .8-square-mile lethal area for machinery protected against 1,300 psi. At this high level of protection, weapon accuracy and the physical area of industrial targets become important because lethal radius is reduced to about 860 feet.

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FIGURE 11

Effect of Population and Industrial Protection (Counterforce Exchange—Countervalue Exchange)



The effect of industrial protection is to reduce damage and raise the cost of inflicting damage. The conclusion of the Boeing study was that Russian methods could protect machinery within the three-day warning that would be provided by a Soviet evacuation. A full-scale Soviet attack could be absorbed, and production could renew in four to twelve weeks. Boeing could be back at its 1978 level of production in about one year. If people and machinery were not protected, the recovery time would be beyond estimation.¹²

IV

Clearly, industrial protection is a critical variable in post-war industrial recovery. Figure 11 illustrates the effects of various

¹² A CIA study (*Soviet Civil Defense*, July 1978) noted that there is "little evidence" of Soviet preparations to harden their industrial machinery. Such an observation is not reassuring, however, in view of the Boeing study's conclusion that "implementation of the necessary protective measures is not easily detectable." Furthermore, the production experts pointed out that even if no specific plans or preparations had been made to harden Soviet factories, it would take only "4 to 6 weeks of concerted national effort" to make a transition to a protected posture.

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levels of protection. The data are based on a counterforce exchange followed by a countervalue exchange—a scenario producing outcomes least unfavorable to the United States—and on a U.S. reserve of 10 per cent.

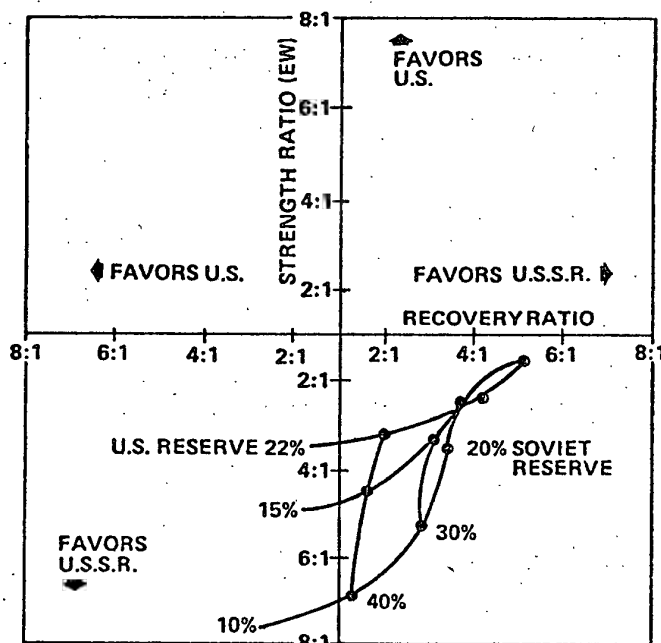
If the Soviet Union chooses to protect both industry and population, the outcome of the conflict moves more in its favor. On the other hand, if both sides are equally well protected, the recovery imbalance is substantially mitigated, leaving only a strength imbalance. But, as we foreshadowed earlier, in such a situation the Soviet Union could dominate the American recovery through a coercive power which only it possessed. It also becomes apparent that options capable of solving the recovery problem will not solve the strength problem, and vice versa. The United States is faced with two problems, each requiring a separate solution. Another point: industrial protection has a double impact on the strength-recovery relationship, affecting not just the amount of damage but the amount of strength that would have to be expended to inflict damage.

Protection also affects reserve choices and, thus, the intensity of a conflict. Figure 12, assuming Soviet protection of population only, illustrates this. The more-horizontal lines (22%, 15%, 10%) are American reserve choices; the more-vertical lines (40%, 30%, 20%) are the Soviet choices. Let us assume that the Soviets hold a 40 per cent reserve. A U.S. choice to hold 10 per cent in reserve, instead of 22 per cent, is to move down the "Soviet Reserve 40%" line, substantially worsening the balance of strength without obtaining a significant improvement in the recovery ratio. A 22 per cent U.S. reserve, however, would motivate the Soviets to spend more of their strength to push the U.S. further along the recovery axis. If each side places approximately equal value on strength and recovery, the optimal point for both sides is where the U.S. holds a 15 per cent reserve and the Soviets hold about 30 per cent in reserve. Civil defense—more protection or less protection—alters this relationship. Figure 13 shows the effect of a worsened disparity between the protection levels of the two sides. The analysis assumes no U.S. protection and Soviet protection of both population and industry. The shape of the curves is different from those in Figure 12. The effect is to motivate both the Soviets and the United States to expend more of their forces and do more damage. The U.S. would hold 10-12 per cent in reserve; the Soviets, between 20 and 30 per cent.

If protection levels are made equivalent (Figure 14 as-

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FIGURE 12

Strength Versus Recovery—CF-CV Exchange
(Reserve Force Sizing)

sumes that both sides protect their population), the trade-off curves become more vertical. The effect is that strength expenditures become more futile. Each side would shoot fewer weapons at its opponent; more forces would be held in reserve; and the *intensity of the conflict would be reduced*. More extensive protection of both societies (e.g., mutual protection of population plus industry) would reduce further still the intensity of a nuclear conflict.

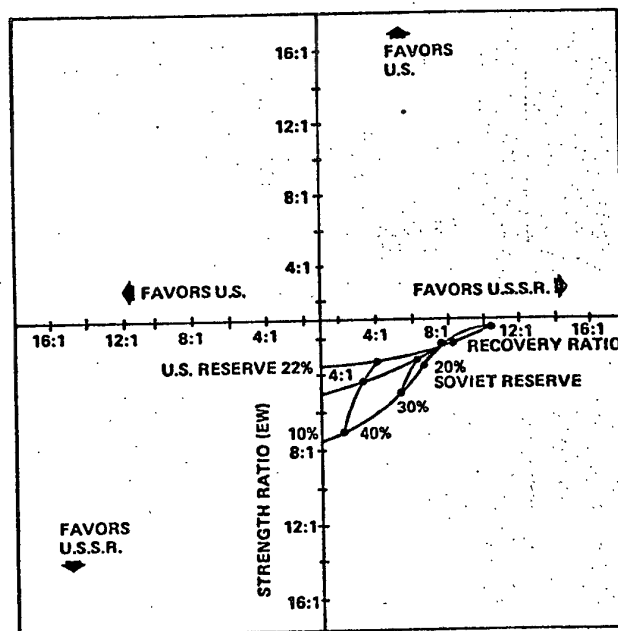
V

Perhaps the most fundamental misconception skewing American evaluations of Soviet civil defense is the tendency to view it as the first and only line of defense against the consequences of a U.S. retaliatory strike. There are indications as well as strong reasons to believe that the Soviets view civil defense as but one

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FIGURE 13

Strength Versus Recovery—CF-CV Exchange Soviet Population and Industry Protected



element of a *secondary* line of defense, the first line of defense being to deter the United States from using its retaliatory forces.

The concept of deterrence through "mutual assured destruction" or "assured retaliation" was probably credible when it originated in the early 1960s because, had the USSR attacked us at that time, we would have had some 7,000 equivalent weapons surviving, and the Soviet Union would have had only a few hundred equivalent weapons left in reserve. (See Figure 15.) The Soviets could well have believed that the U.S. would use a portion of its surviving force to retaliate because the Soviet reserve could not have inflicted substantial additional damage.

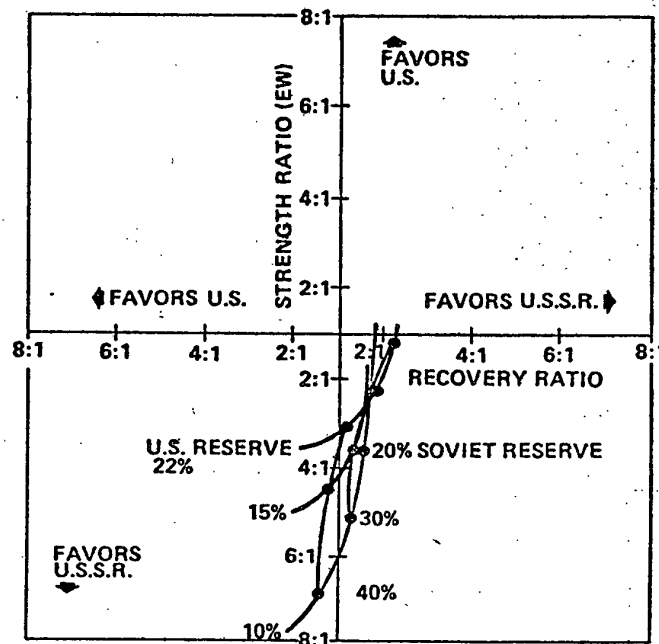
Since the early sixties, the Soviet arsenal has not only increased in size, the warheads have become smaller and more accurate. The effects of these changes are two: (1) the portion of the Soviet arsenal that would be expended in an attack on U.S.

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FIGURE 14

Strength Versus Recovery—CF-CV Exchange

U.S. and Soviet Populations Protected



force is reduced, allowing the USSR to hold a much larger postattack reserve; (2) the U.S. population losses that would result from a Soviet attack on U.S. forces has declined, leaving the U.S. with much more that could be lost in a Soviet *third*-strike.

Those who believe that the 3,500 or so U.S. equivalent weapons (surviving a present or future Soviet counterforce strike) could eliminate the Soviet Union in spite of its civil defenses must also recognize that the Soviet postattack reserve which would be equal to or double that number (today or in 1985, respectively) could certainly destroy the totally unprotected United States.

The most important, but most ignored, factor affecting the credibility of America's assured-retaliation doctrine is the relationship between how much the U.S. would lose in a Soviet first-

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FIGURE 15

Comparative Capability After Soviet First Strike

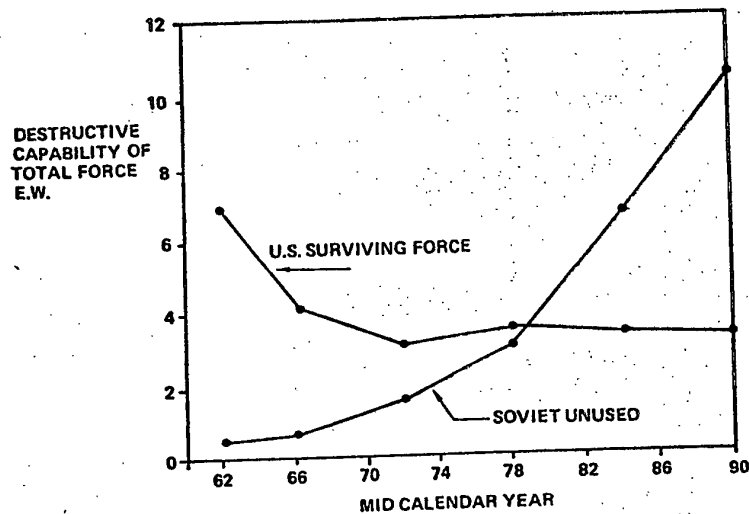
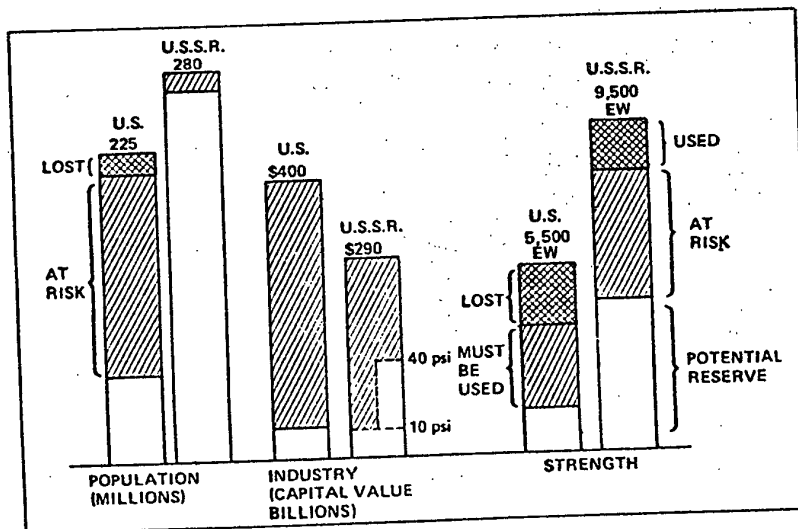


FIGURE 16

Leverage at End of Soviet Counterforce Attack

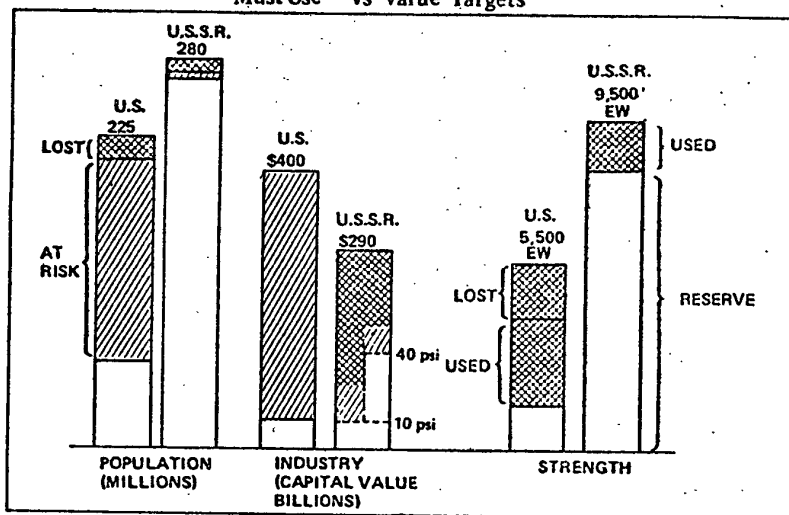


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FIGURE 17

Leverage at End of U.S. Response

"Must Use" vs Value Targets



strike and the amount left to lose (or at risk) to a Soviet third-strike consequent to such a U.S. retaliation. Figures 16 and 17 provide some perspective on this factor. Figure 16 shows that with the 1985 SALT II forces, between 6 million and 14 million Americans would die in a Soviet initial counterforce strike, leaving 144 million still at risk who could be killed in a Soviet third-strike against U.S. cities. The Soviets would have as few as 10 million of their people at risk, depending on how well they choose to protect them. The U.S., being more highly developed, has at risk more industrial value than the Soviet Union. Although it is true that the U.S. could inflict "massive damage on the Soviet economy," the Soviet objective is not damage-denial but recovery. Industrial recovery depends not on how many buildings are intact, but on how much equipment is left. Even without protection, the Soviets would have as much industrial capacity remaining as the U.S., and even modest protection (against 40 psi) would give them a 2:1 or 3:1 advantage.

With respect to forces, 40 per cent of U.S. strength would have been destroyed by the Soviet attack, and the U.S. would have to use roughly an additional 40 per cent promptly or lose it. The Soviets would have expended 25 per cent of their

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force, and an additional 30 per cent would be at risk to a possible U.S. counterforce response, leaving the prospect of a 3:1 or greater Soviet advantage in postexchange reserve strength. Such an imbalance in strength would in itself not be a serious problem; but, combined with an imbalance in protection, the problems could be insuperable. After a Soviet counterforce attack, the U.S. would lose much more by escalation than the Soviet Union. In a crisis, the side that stands to lose the most by escalation tends to make the greatest concessions to avoid escalation, as was seen in 1962.

The point is that *everything the United States professes about deterrence by assured retaliation indicates that the U.S. would likely be deterred from retaliation against Soviet cities.*

Besides raising serious doubts about the credibility of the U.S. deterrent, the above factors affect the capability of the United States to control escalation and the terms on which it could hope to terminate hostilities. The critical problem is that the U.S., having designed forces and communications for a "spasm war," rather than forces that can "prevail in a prolonged struggle" (the Soviet terminology), must either escalate promptly or lose an additional 40 per cent of its strength. The consequences of using this otherwise-forfeited strength are not pleasant to assess. Figure 17 illustrates the situation after expending this "must use" force against Soviet urban-industrial targets. All of the Soviet force not used in the initial strike would remain intact after the U.S. second-strike, giving the USSR a huge military advantage and very little reason not to use a large portion of it against U.S. cities. Soviet population and industry would be only marginally at further risk.

A second U.S. option would be to expend as much of the "must use" force as could be usefully applied to reducing Soviet reserves, and to use the remainder against Soviet cities. Although in this case the Soviets would have somewhat more to lose than in the preceding case, their potential further loss is still dramatically less than America's potential further loss. Moreover, such a response could trigger launch under attack of large portions of the Soviet reserve, the most likely targets at that point in the conflict being U.S. cities.

The concern, then, is that after a Soviet attack the U.S. would have more force in a "must use" condition than it could prudently use. There would be little time for bargaining, and time would be on the side of the Soviet Union. It becomes clear that protection of U.S. population and industry is crucial to the credibility of the U.S. deterrent and that, should deterrence fail, such

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protection will have an important influence on America's ability to control escalation and terminate a conflict on terms even remotely favorable. Also, among all of the U.S. options in a conflict, there are no winning options — only alternative ways to lose. Given projected 1985 SALT II forces, the U.S. has no way to get out of that lower-right, least favorable quadrant.

VI

Because the conclusions we have suggested are so grim, one may be relieved that other studies offer more hopeful conclusions. Is the difference in conclusion based on an invalidation of our premise or method, or does it reflect different premises and different methods? The answer varies from study to study.

A recent CIA study of Soviet civil defense concludes that the present Soviet program would not affect Soviet perceptions of the military balance sufficiently to "embolden them deliberately to expose the USSR to a higher risk of nuclear attack."¹³ This conclusion is reached after noting that 100,000 full-time Soviet personnel are engaged in civil defense, that the program would cost \$2 billion to replicate in the U.S. (roughly twenty times America's present level of spending), and despite the finding that "present civil defenses will improve [the Soviets'] ability to conduct military operations and will enhance the USSR's chances for survival following a nuclear exchange."¹⁴

It would appear that the CIA's conclusion was reached by considering civil defense in isolation from the other factors that would influence each side's actions in a conflict. The most important factors are: (1) the Soviet third-strike potential would seriously inhibit any U.S. retaliation; (2) if the U.S. did retaliate, its need to avoid considerable inferiority in postwar strength would sharply limit the amount of destruction it could impose on the USSR. Also, the CIA's judgment seems to derive from the perspective that Soviet civil defense could not prevent "massive damage" (a U.S. concept of deterrence). Judgment should have been based on the ability of Soviet civil defense to meet its intended objective — speeding recovery — and, in this connection, the CIA did not recognize that most sectors of industry could maintain present levels of production on only one-third of their existing machinery. Further, none of the studies done in the U.S. has accounted for the combined and

¹³ *Soviet Civil Defense*, p. 1.

¹⁴ *Ibid.*, p. 4.

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synergistic effects of civil defense supplemented by air defense and systems with limited capability to intercept ballistic missile warheads.

Nor do our conclusions appear wholly surprising in the light of other recent studies. A study commissioned by the Defense Nuclear Agency measured the strategic balance against forty-four indicators, static and dynamic. Whereas the United States was ahead on all counts at the time of the Cuban Missile Crisis, today it is behind in all but eleven. Of these, two are accounted for by the inexplicable exclusion of the Backfire bomber from pertinent categories, two more by recent intelligence on improved Soviet missile accuracy — leaving seven categories where, owing to America's lead in numbers of MIRVed Poseidon warheads, the U.S. maintains a fragile advantage.¹⁵

It having been illustrated that some studies' optimistic conclusions result from flawed methods and assumptions, it is instructive to summarize the criticisms of those who have reviewed the specifics of our study. As previously noted, the study has been criticized both as overstating and as understating Soviet capabilities relative to those of the U.S.

Those who believe that our study *overstates* Soviet capabilities advance these reasons:

(1) The Soviet Backfire bomber, since it is not counted in the SALT ceiling on strategic delivery vehicles, should not be considered in the analysis, even though it is capable without refueling of doing major damage to U.S. targets.

(2) The Soviet Union may not attack all (about 200) American runways on which the U.S. can hold its B-52 bombers and supporting tankers, even though failure to do so would cut by half the Soviet postwar advantage.

Those who believe that our study *understates* the Soviet postwar advantage relative to that of the U.S. advance these reasons:

(1) The analysis does not account for Soviet reload missiles, even though they are known to exist and even though the SALT agreement will not limit their number or constrain their effective employment in the postwar period.

(2) It is assumed that the U.S. will have warning and will place its forces on full alert even though the data indicate that a surprise attack may produce outcomes more favorable to the USSR.

¹⁵ See "Measures and Trends. . . ." It is worth noting that the American advantage in MIRVed submarine-launched ballistic missiles was considered absolute at the time of the study. Subsequently, it is widely reported, the Soviets have tested MIRVed SS-N-18 missiles.

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(3) All U.S. warning systems are assumed to be fully effective even though they are known to be vulnerable.

(4) The analysis did not recognize the synergistic effects of the Soviets' multi-layered defenses (e.g., a combination of barrier defenses, SA-10 terminal defenses and civil defense to counter a range-limited cruise missile), even though there are indications that this could substantially reduce U.S. capabilities.

The most important qualification of our study is that it is based entirely on present *plans*. These can change for the better, but the record suggests that change will likely be for the worse. In a consideration of what the 1985 SALT forces will be, it is interesting to reflect on a government-wide, informal assessment of the military balance made in late 1975. The conclusion was that the nuclear balance is becoming increasingly precarious — that it is deteriorating very rapidly.¹⁶ A possibility of rectifying this problem was seen, however, because of: (a) plans then in existence for a B-1 bomber, (b) the possibility of speeding up plans for development of a large, highly accurate missile (the M-X) to match the large missiles deployed by the Soviets in the 1970s, (c) the usefulness of the cruise missile if unhobbled by range limitations, and (d) the possibility of speeding up the Trident submarine — in short, by proceeding full steam ahead with the weapon options of that day.

In hoping that the balance may, or must, improve, one must note that the B-1 has been canceled, that research funds for the M-X were cut in half as one of the first acts of the Carter administration, that the cruise missile, already hobbled by the lack of a suitable launcher, was further restricted by SALT II range limitations, and that the Trident program is well behind schedule, with the result that our advantage in submarines, as we retire old ones faster than we can launch new ones, will deteriorate swiftly in the 1980s. In the meantime, it is reported that the Soviets have: (a) tested missiles with accuracies within one-tenth of a nautical mile, hardly less than our own, (b) tested a MIRVed missile for their Delta-class nuclear submarines, and (c) stepped up their deployment of the Backfire. Moreover, their technological momentum is bringing them a continuing stream of new achievements in every principal military area.

What, it must be asked, are the implications of our study? We said at the outset that the most important questions it raises cannot be answered with scientific rigor; rather, that we can only

¹⁶ W. Scott Thompson, then an official in the secretary of defense's office, participated in this study.

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narrow the range of uncertainty by applying analytical tools, in a spirit of scientific enquiry, to the question of war outcomes and civil-defense variables. Yet, to us, the implications seem obvious. Now in a position much the same as that in which the Soviets found themselves in 1962, the United States will presumably do much the same as they did — look for an escape hatch, if there be one. To the assertion that the Soviets are unlikely to provoke so deadly a crisis, we would ask why the political heirs of Lenin and Stalin, and the national heirs of tsars back to Ivan the Terrible, would behave more magnanimously toward us than President Kennedy, an heir to the traditions of Jefferson, Lincoln and Wilson, behaved toward them when vital U.S. interests were engaged.

Indeed, it concerns us that far worse days may well be ahead. And, given the current leadership's propensity to discount trends, those days may well come sooner rather than later, particularly as additional evidence accumulates of an American propensity to avoid crisis situations with the Russians (and their clients) in the Third World.¹⁷ These are issues that must be addressed in a different study. But to suggest that, if deterrence were to fail, the data we present would *not* influence the superpowers in their reactions requires a leap of faith and an ahistorical spirit.

VII

There are, indeed, reasonable directions in which the United States can move. A major policy issue to be decided is whether to restore or to replace the present concept of deterrence: mutual assured destruction. As has been seen, the "balance of terror" is no longer in balance. It is seriously lopsided. Restoring the "mutual" to the mutual assured destruction doctrine would require either that the Soviets eliminate their civil defense and limit their air defense or that the U.S. increase its arsenal to overpower those defenses.

It is extremely unlikely that the Soviet Union would ever agree to abandon or limit its defensive posture, even though the Soviets have agreed to discuss civil defense. In SALT, the Soviets have never relinquished an advantage except in exchange for an equal or larger U.S. concession. The U.S. no longer has any advantage good enough to trade for the highly developed Soviet

¹⁷ See Thompson, *Power Projection*.

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defenses. Moreover, the Soviets have never accepted the rationale of mutual destruction; in private conversations, Soviet officials characterize the concept as senseless and barbaric.¹⁸

To overpower Soviet civil defense would be no easy task if one makes the prudent assumption that plans will be competently executed in a crisis. To overpower the Soviet population defenses would require a five- to tenfold increase in the U.S. strategic arsenal, while industrial protection would dictate a threefold or greater increase, depending upon the strength of supplementary air defense. Such a massive increase in weaponry may well be unaffordable and certainly would be more costly than the Soviet civil defense that it attempts to counter. Moreover, even a huge surviving arsenal would not remove the fear that its use could provoke a Soviet third-strike against America's unprotected cities.

For these reasons, we believe it would be better to abandon the present destruction-oriented concept of security and move toward a survival-oriented or protection-oriented doctrine. The objective would be to ensure that neither side can gain any advantage by using nuclear weapons. It would emphasize survivability of society rather than vulnerability of society. Moreover, such an approach would complement the arms-control objective of limiting offensive power.

A survival-oriented doctrine would include several elements, the most important of which would be protection of U.S. society — its people as well as the industry which supports their standard of living. Civil defense is by far the most economical means of protection. Air defense and ABM defense should also be given serious consideration, but only as an adjunct to civil defense. The reason is that a combination of passive (civil) defense and active (air and ABM) defense reduces the complexity and cost of the active-defense elements and substantially increases the futility of using nuclear weapons.

In addition to protecting U.S. society, it is crucially important to restructure America's strategic forces. Four basic requirements must be met:

(1) Our strategic force posture should *not* create an incentive for a Soviet surprise attack. Otherwise, the costs of effectively protecting society as well as the costs of the forces themselves are dramatically increased. To avoid creating an incentive for surprise attack the U.S. would have to place

¹⁸ Conversations of T. K. Jones, during 1971-1974, while serving with the U.S. SALT delegation in Helsinki, Vienna and Geneva.

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most of its strategic capability in forces having either a high peacetime alert rate or a substantial insensitivity to surprise attack. ICBMs have a peacetime alert rate of nearly 100 per cent, and it is conceivable that bombers could be designed and based in a way that they would survive equally well under both peacetime and generated-alert conditions. If the bombers could be made insensitive to surprise attack, the 50 or 60 per cent peacetime alert rate of the U.S. submarine force would not by itself create an incentive for surprise attack.

(2) *Stability* requires that the survivability and capability of each force be balanced so that it would be a losing proposition to attack. For example, until the Soviets acquire the ability to locate U.S. submarines at sea, an attempt to bombard submarine operating areas would use up more Soviet weapons than it would destroy U.S. weapons. (Submarine bases would continue to be an attractive target.) Under the multiple aim point (MAP) basing concept, U.S. ICBMs would no longer be candidates for attack, for the Soviets would have to attack a number of relatively low-cost protective facilities in order to destroy just one U.S. ICBM. For the Minuteman III missile, there would be no incentive to attack a system with a facility/missile ratio of 5:1. Increasing the ratio or supplementing the system with a limited-capability ABM would add to the disincentive to such an attack.

(3) *Limiting offensive power* is also important. A big SALT loophole is that reload missiles are not effectively controlled. Neither equality nor security can result from an arrangement analogous to one where a nation has a number of rifles, each with a single bullet, while the opposing nation has an equal number of rifles with unlimited ammunition. The reload loophole must be closed.

(4) *Postattack endurance* is a crucial requirement if the United States is to avoid putting its president in a position where he must immediately use his surviving forces or lose them. Postattack endurance is essential to preserve America's retaliatory strength long enough to seek alternative, nonescalatory solutions.

It will take a national decision to restore a position of strategic parity. The alternative is to concede victory in advance, since the Soviet leadership is well aware of the trends presented in this essay. Such a concession would hardly be in the American tradition, but the American people must know what is happening. The whole nation must first of all understand the peril and then be prepared to take the action required to regain a credible deterrent. Even then, a healthy amount of luck will be required to emerge unscathed from what will be an irretrievably vulnerable period during the first half of the 1980s.